

**IN THE UNITED STATES DISTRICT COURT  
FOR THE SOUTHERN DISTRICT OF NEW YORK**

IN RE FOREIGN EXCHANGE  
BENCHMARK RATES ANTITRUST  
LITIGATION

No. 1:13-cv-07789-LGS

**SUPPLEMENTAL REPORT OF  
HAL J. SINGER, PH.D.**

**September 14, 2022**

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## INTRODUCTION

1. I have been asked by counsel for Plaintiffs to respond to the memorandum in support of Credit Suisse's *Daubert* motion ("*Daubert* Memo") submitted against me,<sup>1</sup> as well as the supporting declarations of Dr. Allan Kleidon and Prof. Justin McCrary.<sup>2</sup> As detailed below, having reviewed these materials,<sup>3</sup> I am not persuaded to revise any of the opinions reached or methodology implemented in my prior reports.<sup>4</sup> Dr. Kleidon and Prof. McCrary are simply wrong on the economics.

2. Most importantly, my primary opinions stand unshaken: the conduct of Defendants during the Class Period—specifically, Defendants' discussion and coordination of spreads via private, exclusive, interbank chatrooms in a market with a structure highly susceptible to manipulation<sup>5</sup>—is consistent with collusion and inconsistent with competition. This conduct is statistically associated with higher spreads in the dealer-to-customer segment during the period in which the private chat network was active.

## QUALIFICATIONS

3. My background and qualifications are included in my Merits Report.<sup>6</sup>

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1. Memorandum of Law in Support of Credit Suisse Defendants' *Daubert* Motion to Exclude Plaintiffs' Proposed Expert Opinions (August 26, 2022).

2. Declaration of Allan W. Kleidon, Ph.D. (August 26, 2022) [hereafter Kleidon Declaration]; Declaration of Prof. Justin McCrary (August 26, 2022) [hereafter McCrary Declaration].

3. My relied upon materials are included as the appendix to this report.

4. Rebuttal Report of Hal J. Singer, Ph.D. (July 31, 2022) [hereafter Singer Liability Reply]; Merits Report of Hal J. Singer, Ph.D. (January 23, 2020) [hereafter Singer Merits Report]; Merits Rebuttal Report of Hal J. Singer, Ph.D. (August 13, 2020) [hereafter Singer Merits Reply]; Class Certification Report of Hal J. Singer, Ph.D. (May 31, 2018) [hereafter Singer Class Report]; Class Certification Report of Hal J. Singer, Ph.D. (January 31, 2019) [hereafter Singer Class Reply].

5. Singer Liability Reply (July 31, 2022) at Part I.

6. Singer Merits Report (January 23, 2020) at Appendix 4.

**I. DEFENDANTS' *DAUBERT* MEMO CLAIMS ARE FATALLY FLAWED AND FAIL TO UNDERMINE MY CONCLUSIONS**

4. The various critiques of my opinions and analyses presented in the *Daubert* Memo are baseless and unreliable and do not undermine any of my conclusions.

**A. Credit Suisse's Characterization of My Interpretation of Chat-Based Evidence Is Incorrect**

5. Credit Suisse claims that I have offered “no empirical or any other reliable analysis to determine how many chats are necessary to monitor a conspiracy.”<sup>7</sup> In doing so, Credit Suisse ignores that the list of chats that appear in my most recent report<sup>8</sup> (which I understand to be illustrative and not exhaustive) do not appear in a vacuum, nor do they appear with any “gloss.”<sup>9</sup> Instead, the list provides evidentiary support for my economic opinions regarding the plausibility of the conspiracy. Specifically, qualitative evidence consistent with collusion—for example, rivals would not discuss pricing information of the kind seen in the chats absent an agreement not to compete—supports the notion that Defendants were able to use their relative dominance in the FX marketplace<sup>10</sup> to effectuate relatively higher concentration within the industry.<sup>11</sup> Further, such evidence is consistent with a common goal and coordination action between conspirators, and inconsistent with unilateral conduct.<sup>12</sup>

6. In addition to providing qualitative evidence consistent with collusion, the chat list informs the construct of the econometric model, in particular testing the hypothesis that the FX market—both the interbank and dealer-to-customer segments—performed differently during the

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7. *Daubert* Memo at 4.

8. Singer Liability Reply (July 31, 2022) at Appendix 1.

9. *Daubert* Memo at 4.

10. Singer Liability Reply (July 31, 2022) ¶22.

11. Singer Merits Report (January 23, 2020) ¶28.

12. Singer Merits Report (January 23, 2020) ¶38.

alleged conspiracy. This leads me to my next point, which is that I have, in fact, tested empirically whether the number of chats participated in by Defendants was “necessary to monitor a conspiracy” that inflated spreads. My econometric analysis confirms that spreads were significantly wider—both statistically and economically—during the alleged conspiracy and therefore the chats participated in were more than the quantum necessary to effectively monitor and enable the conspiracy.<sup>13</sup> If the number of chats were less than necessary to monitor and maintain a successful cartel, I would observe no spread inflation.

7. Further, there is no specific threshold of chat frequency beyond zero necessary to be relevant to my analysis. In the absence of the incentives associated with the Challenged Conduct, “signaling one’s pricing intentions to a rival would not have made sense.”<sup>14</sup> As I pointed out in my most recent report, “there is no *threshold* at which detailed price discussion becomes problematic; economically rational horizontal competitors *do not* exchange contemporaneous, de-anonymized price information, as a matter of basic economic theory.”<sup>15</sup>

8. Such price discussion to any extent has been long and consistently recognized as incompatible with competitive behavior and well within the purview of analysis and interpretation by economists (contrary to Credit Suisse’s claim<sup>16</sup>). In his seminal work, *The Wealth of Nations*, one of the foundational tomes of modern economic theory, the “Father of Economics,” Adam Smith, observed, “People of the same trade seldom meet together, even for merriment and

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13. Singer Merits Report (January 23, 2020) ¶41.

14. Singer Merits Report (January 23, 2020) ¶24; *see also* MICHAEL D. WHINSTON, LECTURES ON ANTITRUST ECONOMICS 20-24 (MIT Press 2008) (discussing how oligopolists seeking to come to a competitive agreement, but cannot sign a binding agreement, can overcome the coordination problem through repeated discussion).

15. Singer Liability Reply (July 31, 2022) ¶3.

16. *Daubert* Memo at 4.

diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices.”<sup>17</sup> More recent research, cited extensively in my prior reports, demonstrates that economists commonly incorporate qualitative information when analyzing the prospect of collusion.<sup>18</sup> As pointed out in my prior reports, to contend that years of communication between market-making competitors about prices shown in the dealer-to-customer segment of the FX marketplace would somehow *not* have qualified as anticompetitive would be inconsistent with centuries of fundamental economic principles and empirical work.<sup>19</sup>

9. Credit Suisse has also mischaracterized my prior testimony in an attempt to imply that I did not “understand [the] import” of the chats listed in my most recent report.<sup>20</sup> In fact, that testimony referred to a collection of chats—reviewed by a completely different expert, Mr. Robin Poynder—distinct from the chat evidence reflected in my most recent report and, further, no longer under consideration as an exhibit in this matter. I was not asked to review the former, but did supervise the collection of the latter.<sup>21</sup>

10. To summarize, my most recent report presented a list of chats that meet the criterion of direct customer pricing communications among horizontal competitors.<sup>22</sup> I performed no analysis of the chats in a vacuum, but have used their existence to inform the construction and

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17. ADAM SMITH, AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS 105 (W. Strahan & T. Cadell, London 1776).

18. *See, e.g.*, Singer Liability Reply (July 31, 2022) ¶¶38-40.

19. Singer Liability Reply (July 31, 2022) ¶37.

20. *Daubert* Memo at 4.

21. Singer Liability Reply (July 31, 2022) at fn. 39.

22. CS-FXLIT-00000023 at -24 (Credit Suisse’s Antitrust and Unfair Competition policy reads “[E]mployees may not disclose to competitors prices, pricing plans, inventory levels, specifics about customer transactions or orders, trading strategies, long or short positions, or any other *competitively sensitive information* unless there is a legitimate business justification for the disclosure and you have consulted with your manager, who should consult further with the Legal Department.” [emphasis added]).

interpretation of my regression model and to evaluate the consistency of the entirety of the evidence with the presence of the challenged manipulation. My econometric model demonstrated spread inflation during the Class Period, indicating that the chat evidence was consistent with the existence of a conspiracy and therefore that the Challenged Conduct was sufficient to inflate spreads in both the interbank and dealer-to-customer segments of the FX market. To characterize my reliance upon the chats as divorced from my economic opinions, as the *Daubert* Memo does, is misleading.

**B. Defendants' Characterization of My Interpretation of Regulatory Settlements and Guilty Pleas Is Incorrect**

11. Credit Suisse claims that I “should be precluded from” discussing “regulatory settlements and guilty pleas entered into by certain banks.”<sup>23</sup> In fact, given that Credit Suisse’s expert Dr. Mathur herself discusses the same settlements and pleas,<sup>24</sup> they cannot seriously contend that the conduct of economic agents in response to regulatory action associated with the Challenged Conduct is outside the purview of economics. I agree with Dr. Mathur that regulatory settlements and guilty pleas are not necessary to assess the economic effects of an alleged conspiracy.<sup>25</sup> However, such evidence does provide corroboration of the extensive quantitative and qualitative evidence consistent with the conspiracy alleged in this case.<sup>26</sup> To imply that I have

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23. *Daubert* Memo at 4-5.

24. Expert Report of Divya Mathur, Ph.D. (May 20, 2022) [hereafter Mathur Report] at Section VI. I understand the District Court granted Credit Suisse’s motion to exclude evidence and argument concerning a consent order and related press between Credit Suisse and the New York Department of Financial Services, in part, as it would be cumulative of the chats themselves. Opinion and Order, ECF 1880 at 1.

25. *Id.*

26. Singer Liability Reply (July 31, 2022) ¶86. As the District Court noted in denying Credit Suisse’s motion to exclude guilty pleas, “Evidence of the challenged guilty pleas is highly probative of the existence of a conspiracy . . . .” Opinion and Order, ECF 1880 at 5.

relied more extensively on the evidence of regulatory settlements and guilty pleas is incorrect and mischaracterizes my testimony.

**C. Credit Suisse’s Characterization of My Regression Model Is Nonsensical, Misleading, and Fatally Incorrect**

12. Credit Suisse and its expert, Prof. McCrary, grossly mischaracterize my regression model, misleadingly re-label variables, and are altogether misguided in their critique of my econometric analysis.

**1. Credit Suisse’s Characterization of My Time Fixed Effects Are Incorrect and Untethered to the Econometric Literature**

13. Credit Suisse and Prof. McCrary claim “the standard approach for ‘year-fixed effects’ variables is to run them by calendar year.”<sup>27</sup> Prof. McCrary goes so far as to claim that “he is not aware of any publication in the economics literature that uses a year-fixed effects variable with anything other than a *calendar* year.”<sup>28</sup> This is an odd claim, as the *fiscal* year, which is what my fixed effects are based on, is commonly used as a control variable in the economics and financial literature.<sup>29</sup>

14. Credit Suisse’s claim that “statistical software would not have permitted Singer’s regression to run had he used a standard calendar year”<sup>30</sup> is misleading; the software would simply re-label the conduct effect as part of the year fixed effects during the Class Period. The way I have specified the econometric model allows the software to measure the effect of the alleged

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27. *Daubert* Memo at 7.

28. McCrary Declaration ¶¶6, 24 (emphasis added).

29. See Paul Oyer *Fiscal year ends and nonlinear incentive contracts: the effect on business seasonality*, 113(1) QUARTERLY JOURNAL OF ECONOMICS 149–185 (1998). See also Joyaditya Laik & Prakash Mirchandani, *Effect of seasonality, sales growth rate, and fiscal year end on cash conversion cycle*, DECISION SCIENCES 1–21 (2021), available at <https://drive.google.com/file/d/1YyHA7UkRzyIUV97Xx5tb0d7V4cd01CEP/view>.

30. *Daubert* Memo at 13.

conspiracy; it does not *create* an effect through some statistical trickery. As demonstrated below, Credit Suisse's and Prof. McCrary's "alternative" models are entirely consistent with spread inflation associated with the Challenged Conduct and with my regression model as it is presented.

15. In fact, this is not a new argument, nor is it one I have left unrebutted as Credit Suisse implies.<sup>31</sup> Dr. Ordoover first presented the analysis now repeated by Prof. McCrary. I included the same demonstrative in my Class Reply<sup>32</sup> that is reflected in Table 1 below.

TABLE 1: PROF. MCCRARY'S EXHIBIT 6, COLUMNS (1) AND (4), DEMONSTRATING THE RE-LABELING OF THE CONDUCT COEFFICIENT

Independent Variable	Singer Version	Conduct July 2013 to December 2013	Difference
	(1)	(4)	(4) - (1)
Conduct	0.0000408	0.0000408	
2007 Time FE	0.0058455	0.0058863	0.0000408
2008 Time FE	0.0059773	0.0060180	0.0000408
2009 Time FE	0.0059421	0.0059828	0.0000408
2010 Time FE	0.0060030	0.0060438	0.0000408
2011 Time FE	0.0058444	0.0058851	0.0000408
2012 Time FE	0.0056676	0.0057083	0.0000408
2013 Time FE	0.0057117	0.0057117	0
2014 Time FE	0.0057566	0.0057566	0
2015 Time FE	0.0055958	0.0055958	0
Log Order Book Depth	0.0000168	0.0000168	
Daily Volatility	0.4053894	0.4053894	
Daily Order Flow	-0.0000005	-0.0000005	
TED Spread	0.0000380	0.0000380	
VIX Index (Log Change)	-0.0000604	-0.0000604	
MSCI Index (Log Change)	0.0000541	0.0000541	
Investor Sentiment Index	0.0000601	0.0000601	
Last Trading Day	0.0000061	0.0000061	
Observations	99,493,246	99,493,246	
R-squared	37.76%	37.76%	

As shown in the "Difference" column, the time fixed effects during the Class Period in Prof. McCrary's model are higher by *exactly* the amount associated with the conduct coefficient. This

31. Singer Class Reply (January 31, 2019) ¶¶59-60.

32. Singer Class Reply (January 31, 2019) at Appendix 2.



indicates that Prof. McCrary has simply relabeled the effect of the conduct coefficient outside of his “alternative” Class Period, classifying the effect as elevations in the time fixed effects. Prof. McCrary’s model still predicts inflated spreads throughout the Class Period, however they are labeled.

16. Prof. McCrary also presents two other misleading modifications of my econometric model, which are rebutted in Part III below.

**2. Credit Suisse’s Characterization of My Cointegration Regressions Defies Basic Mathematical Reasoning**

17. Credit Suisse claims that my “Cointegration Regressions find only that bid and ask *prices* in the dealer-to-dealer market are correlated with bid and ask *prices* on dealer-to-customer trades.”<sup>33</sup> However, spreads are a linear function of bid and ask prices, as shown below:

$$\textit{Spread} = \textit{Ask Price} - \textit{Bid Price}$$

In the equation above, it is obvious that there is no way for *Spread* to increase without at least one of two things occurring: (1) *Ask Price* increasing; or, (2) *Bid Price* decreasing. My interbank regression model demonstrates that *Spread* does, in fact, increase in the interbank segment with the Challenged Conduct. This directly implies that either *Ask Price* is elevated or *Bid Price* is suppressed (or both) in the interbank market. My cointegration regressions demonstrate that *Ask Price* in the interbank market is highly correlated with *Ask Price* in the customer segment and that *Bid Price* in the interbank segment is highly correlated with *Bid Price* in the customer segment. Given these correlations, it is highly statistically unlikely that *Ask Price* is elevated in the interbank segment and not elevated in the customer segment, and the same is true for

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33. *Daubert* Memo at 11.

*Bid Price*. In other words, if both sides of an interval move together, so does the width of the interval. It is mathematically unreasonable to state otherwise.

18. Although the steps described above are sufficient, I also undertook a confirmatory analysis, as presented in my Merits Reply.<sup>34</sup> This analysis confirms that an increase in the interbank bid-ask spread implies a corresponding decrease in the interbank bid price and/or increase in the interbank ask price. Customers bear the economic burden of these wider spreads as long as spreads are also wider in the customer segment, which, as my cointegration regressions demonstrate, they decidedly are.

19. It bears noting that prices in the interbank segment are related to prices in the customer segment via a “feedback” mechanism as well. That is, prices in the interbank segment do not exclusively cause prices in the dealer-to-customer segment; the reverse is also true. There are multiple transmission mechanisms between the two, serving as a feedback loop. For example, adverse selection-widened spreads in the interbank market likely raised costs borne by Defendants, further incentivizing widening in the dealer-to-customer segment. In the opposite direction, activity on the private chat networks active in the dealer-to-customer segments likely raised profits for Defendants, allowing them to bear higher costs (i.e. wider spreads) in the interbank market.<sup>35</sup>

20. As a final check on my results, I consulted the FX literature and record evidence, both of which suggest that these correlations do, in fact, exist, and are robust. This fact is well-recognized in the literature and by Defendants’ economists.<sup>36</sup>

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34. Singer Merits Reply ¶¶69-71.

35. Singer Class Reply ¶68.

36. Singer Liability Reply (July 31, 2022) at fn. 226-227, citing both the economic literature and the testimony of Dr. Melvin (wherein Dr. Melvin states, “And so people would use [EBS] as

### 3. Credit Suisse's Characterization of The Trades Included in My Cointegration Regressions Are Misleading

21. Credit Suisse takes further issue with the customer-segment prices analyzed in my cointegration regressions, claiming that I do “not actually analyze prices paid by class members.”<sup>37</sup> This is not correct. Class Member prices exist in the customer segment. Further, I did apply several filters designed to omit trades outside of the Class definition, in two stages. *First*, I limited the data analyzed to spot trades, and eliminated trades that were internal to the banks, prime broker trades (which reflect another entity trading under a Defendant's name), among other types of trades that failed to pass validation screens.<sup>38</sup> *Second*, I further excluded electronic multibank platform transactions (conservatively encompassing all liquidity-providing transactions), non-U.S. transactions, and transactions at the fix.<sup>39</sup> Upon doing so, my conclusions are unchanged.<sup>40</sup> This result is wholly unsurprising, as the prices for transactions that fall within the Class definition are bound to be very highly correlated with non-Class trades. However, to the extent that these screens were not effective in eliminating non-Class trades, my conclusions are unchanged; even if one posits that certain trades outside the Class Definition always transact at a premium (or discount) to Class member trades, this would not upset the correlations established in my reports.<sup>41</sup>

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sort of a benchmark price, and spreads go up from there. And so it does serve a very useful function in terms of, as I say, the price discovery, particularly for the level of price, the midpoint. That's what matters the most. The spread is also, of course, important. But EBS is relevant, and as spreads widen on EBS, they are widening across the market[.]”).

37. *Daubert* Memo at 12.

38. *See* Singer Merits Report (January 23, 2020) at fn. 159.

39. *See* Singer Merits Reply (August 13, 2020) at Table A6.

40. *See* Singer Merits Reply (August 13, 2020) at fn. 178. After excluding certain transactions, Defendant bank prices and EBS prices remain cointegrated and the EBS price explains the vast majority of the variation in the prices that banks charge to customers. *See also* Singer Merits Report (January 23, 2020) ¶¶63-64.

41. *Singer Merits Reply* (August 13, 2020) at fn. 178.

22. Further, my report was not meant to present a damages estimate. The inclusion of non-Class-member trades, in this case, does not introduce any bias that could upset my spread-widening regression or my correlation results. Specifically, what Credit Suisse is implying is that there is some bias being introduced by the inclusion of certain non-Class trades—specifically, “transactions between a Defendant’s foreign desk and a U.S. domiciliary operating abroad, resting orders, benchmark trades, and trades where a class member provided liquidity”<sup>42</sup>—within one of the two stages of my analysis. In order for bias to be introduced in the interdealer segment, the distribution of these trades (*e.g.*, benchmark, liquidity-provision, and foreign-desk trades) would have to be correlated with the Class Period, meaning that the Challenged Conduct alleged somehow affected the frequency in which these trades were executed during the Class Period relative to after the Class Period. Credit Suisse has not demonstrated this is the case, nor have they posited any *a priori* reason to assume so. They also have failed to introduce any evidence in the form of academic literature or by putting forth an alternative model indicating the absence of spread widening once these trades are omitted. In order for bias to be introduced in the customer segment, these trades (*e.g.*, benchmark<sup>43</sup>, liquidity-provision, foreign-desk, and resting-order trades) would have to be so abundant in the customer segment as to completely dominate the correlation analyses. In other words, Credit Suisse would have to suggest that if these trades were excluded, correlations would fall dramatically. There is no evidence that this is the case, and Defendants’ experts have never introduced a model that suggests it is the case. Further, such a theory flies in the face of the literature. It is highly unlikely that the interbank segment would be

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42. *Daubert* Memo at 12.

43. I understand that *e.g.* benchmark trades represent only 0.8% of trades in the dealer-to-customer database. *See* workpapers, Singer Merits Report (January 23, 2020).

considered the “benchmark”<sup>44</sup> for the customer segment if such correlations depended upon this limited subset of trades.

**D. Defendants Dispute the Theory of Adverse Selection and the Volumes of Research Supporting Its Existence and Impact**

23. Defendants claim that I present the “transmission theory” of “adverse selection” without evidence,<sup>45</sup> ignoring the volumes of financial and economic literature I cite in support of this well-established phenomenon.<sup>46</sup>

24. As previously described in my Merits Reply, in a study of information asymmetries in *inter-dealer* FX markets,<sup>47</sup> Professor Richard Payne of the London School of Economics found that asymmetric information accounts for a significant amount of the average bid-ask spread,<sup>48</sup> and explains that “faced with the possibility of trading with a better-informed individual, uninformed liquidity suppliers widen the bid-ask spreads that they charge.”<sup>49</sup> Similarly, Professor Carol Osler of Brandeis University has noted that “[a]dverse selection could, nonetheless, be an important determinant of spreads in the *interbank* market. Information definitely appears to be asymmetric in that market and the evidence is consistent with the hypothesis that spreads include a significant adverse selection component.”<sup>50</sup> Elsewhere, Professor Osler explains that adverse selection has a

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44. Singer Liability Reply (July 31, 2022) at fn. 226-227, citing both the economic literature and the testimony of Dr. Melvin.

45. *Daubert* Memo at 13.

46. Singer Merits Reply (August 13, 2020) ¶95.

47. Richard Payne, *Informed trade in spot foreign exchange markets: An empirical investigation*, 61 JOURNAL OF INTERNATIONAL ECONOMICS (2003) 307–329, 307 [hereafter “Payne”] (emphasis added).

48. *Id.* at 307.

49. *Id.* at 308.

50. Carol Osler, *Market Microstructure, Foreign Exchange*, in *ENCYCLOPEDIA OF COMPLEXITY AND SYSTEM SCIENCE* 607-608 (Springer 2011) (emphasis in original; citations omitted).

“significant influence on *interbank* spreads[.]”<sup>51</sup> My review of the literature is entirely consistent with spread-widening associated with the information asymmetry stemming from the Challenged Conduct.

25. Further, it bears noting that adverse selection is not, by any means, the exclusive mechanism I theorize likely widened spreads borne by Class Members nor mutually exclusive of the simplest explanation for spread widening in the dealer to customer segment. The discussions in the private chat networks are consistent with direct spread widening and are a significant source of the information asymmetry which increased adverse selection risk in the pre-trade anonymous interbank market.

**E. Credit Suisse Ignores My Empirical Evidence Supporting Horizontal and Vertical Correlations**

26. Credit Suisse nonsensically claims that I assert vertical and horizontal correlations without “any methodology or empirical support.”<sup>52</sup> In fact, I demonstrate both vertical and horizontal correlations empirically in multiple ways in my various reports.

27. In my Class Reply,<sup>53</sup> I demonstrate via correlation matrices that spreads of different notional sizes (vertical) are highly-statistically-significantly correlated. My analysis demonstrates that, of the 1,547 correlation coefficients generated in this analysis (across 38 randomly-selected currency pairs), 91 percent are statistically significant at the five percent level or better, and 89

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51. Carol Osler & Xuhang Wang, *The Microstructure of Currency Markets*, in H. KENT BAKER AND HALIL KIYMA MARKET MICROSTRUCTURE IN EMERGING AND DEVELOPED MARKETS: PRICE DISCOVERY, INFORMATION FLOWS, AND TRANSACTION COSTS 79-97, 89-90 (Chapter 5) (John Wiley 2013) [hereafter “Osler & Wang (2013)”] (emphasis added) (explaining that adverse selection has “a significant influence on interbank spreads in the liquid currency pairs”); *Id.* at 90 (“Adverse selection and inventory risk are also important determinants of interdealer spreads in emerging market currencies.”).

52. *Daubert* Memo at 13.

53. Singer Class Reply (January 31, 2019) at Appendix 1.

percent are statistically significant at the one percent level or better. With regard to horizontal correlations, I use currency pair “triangles”—e.g. EUR/JPY, USD/JPY, EUR/USD—to demonstrate that the direct spread of one component of the triangle (*e.g.* the spread observed in EBS for EUR/JPY) was highly-statistically-significantly associated with the indirect spread composed of the other two components. Together, both of these analyses provide empirical support for the correlation-based transmission theory.

28. In my Merits Reply,<sup>54</sup> I explain that, beyond the fundamentals of how risk is assessed in the FX marketplace—with which Dr. Kleidon agrees<sup>55</sup>—my primary regression model also supports the existence of vertical correlations.<sup>56</sup> Further, I point out that Dr. Kleidon did, in fact, concede that the direct spreads used in my horizontal correlation analysis are partially explained by indirect spreads. This is all that is required to empirically establish horizontal correlations.<sup>57</sup>

29. To summarize, the claim that I “lack[] any methodology or empirical support for these opinions” is demonstrably false.

#### **F. Credit Suisse Ignores Spread Matrices in Concluding That Spreads Are Unstable**

30. Credit Suisse claims that I “rely on cherry-picked, anecdotal data that cannot support” a conclusion “that spreads are generally ‘durable’ or ‘stable.’”<sup>58</sup> Again, this claim is incorrect. The evidence I rely upon in forming my opinion regarding spread stability is two-fold:

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54. Singer Merits Reply (August 13, 2020) at II.B.3-4, III.B.

55. Singer Merits Reply (August 13, 2020) ¶85, citing Dr. Kleidon (“quoted spreads in larger sized trades are generally larger than quoted spreads in smaller sized trades, all else equal”).

56. Singer Merits Reply (August 13, 2020) ¶84; *see also* Singer Merits Reply (August 13, 2020) ¶118, showing that Defendants’ expert Dr. Melvin concurs.

57. Singer Merits Reply (August 13, 2020) ¶80.

58. *Daubert* Memo at 17-18.

(1) chat evidence indicates that traders saw spread information as durable, asking about the right spread “these days” on several occasions;<sup>59</sup> (2) Defendants and other significant industry participants, including BlackRock, relied upon quarterly (or even less frequent) spread matrices.<sup>60</sup> Neither of these behaviors is rational in the absence of some degree of spread stability in the marketplace.

## II. DR. KLEIDON’S ADDITIONAL CLAIMS FAIL TO UNDERMINE MY CONCLUSIONS

31. In addition to the arguments and analyses presented in Credit Suisse’s *Daubert* Memo and rebutted above, Dr. Kleidon also makes the following claims: (1) that my regression is not robust to the complete removal of my highly significant time fixed effect variables; (2) that my regression is not robust to arbitrary redefinition of the time fixed effects. Neither of these arguments persuades me to change my opinions or alter my methodology.

32. With regard to (1), Dr. Kleidon, like Prof. McCrary and Dr. Ordoover before him, does not cite to any authority to justify dropping explanatory variables with a strong basis in economic theory that contribute significantly to the model’s explanatory power (nor could he).<sup>61</sup> According to elementary economic principles, removing the time fixed effects would generate omitted variable bias.<sup>62</sup>

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59. Singer Liability Reply (July 31, 2022) ¶27.

60. Singer Liability Reply (July 31, 2022) ¶53.

61. Singer Class Reply (January 31, 2019) ¶57.

62. JEFFREY WOOLDRIDGE, *INTRODUCTORY ECONOMETRICS: A MODERN APPROACH* 89-94 (South-Western Cengage Learning 4th ed. 2009). The only exception to this rule occurs in the rare case in which the omitted variables happen to be uncorrelated with the variables included in the regression model. This exception does not apply here: The time period control variables are correlated with the conduct variable, as evidenced by the fact that the coefficient on the conduct variable changes substantially when Dr. Kleidon (inappropriately) excludes the time-period fixed effects from the regression model.



33. I have already demonstrated that Dr. Kleidon's and Prof. McCrary's claim that my conclusions hinge on a precise timeframe defined by the time fixed effects is incorrect. *First*, my conclusions are robust to using alternative endpoints for the Class Period.<sup>63</sup> *Second*, the conduct coefficient is calculated from all of the data, not just the abbreviated time periods that Prof. McCrary and Dr. Kleidon assert.<sup>64</sup> *Third*, when any of 52 six-month slices of the Class Period and Clean Period are compared, the data show significantly wider spreads during the class period—both on average, and for the vast majority of time periods.<sup>65</sup>

34. Dr. Kleidon's claim that my conclusions are invalidated based on his arbitrary manipulations of the time fixed effects is wrong.<sup>66</sup> Contrary to Dr. Kleidon's assertion, I did not arbitrarily select the time fixed effects, but instead chose time fixed effects that are both (1) consistent with standard practice in the literature; and (2) symmetric with respect to the end of the Class Period. As Dr. Kleidon concedes, holding other factors constant, my regression measures the conduct through "a comparison of half-spreads for two six-month periods: 2H 2013 versus 1H 2014."<sup>67</sup> Dr. Kleidon's arbitrary manipulations throw off that symmetry in nonsensical ways. For example, if Dr. Kleidon is to be believed, the effect of the alleged conspiracy can be meaningfully measured by searching for a decrease in spreads during a single day of the clean period—and New Year's Day at that.<sup>68</sup>

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63. Singer Class Report Table 1.

64. Singer Merits Reply ¶40.

65. Singer Merits Reply (August 13, 2020) ¶¶44-45.

66. Kleidon Declaration ¶16.

67. Kleidon Declaration ¶8.

68. In one of his arbitrary manipulations, Dr. Kleidon defines the time fixed effects as spanning, e.g., 1/2/2013 -1/1/2014 (and similarly for other years). This leaves just a single day (New Year's Day 2014) in which Dr. Kleidon's time fixed effects do not overlap with the Class

35. Dr. Kleidon's claim that that the time fixed effects must be equal between the two half-years composing each fiscal year is not grounded in any econometric authority or standard econometric principle.<sup>69</sup> Dr. Kleidon employs no econometric tests of any kind to support his assertion. In contrast, I performed standard econometric tests to confirm that my time fixed effects are highly statistically significant and contribute to the regression's explanatory power.<sup>70</sup>

36. The corkage analogy Dr. Kleidon presents is misleading.<sup>71</sup> My regression controls for a range of factors beyond time fixed effects. To extend his analogy to comparing two restaurant bills, my regression does, in fact, control for differences in the cost of food, the type of food ordered, and a variety of other factors that might impact meal price. The corkage analogy is also misleading because my regression uses millions of data points. To continue the analogy, if one were to calculate the percentage difference between millions of restaurant bills with and without corkage fees, one could in principle arrive at a statistically reliable estimate of the corkage fees, because random differences in food purchases would cancel due to the law of large numbers.

### **III. PROF. MCCRARY'S ADDITIONAL CLAIMS FAIL TO UNDERMINE MY CONCLUSIONS**

37. In addition to the arguments and analyses presented in Defendants *Daubert* Memo and rebutted above, Prof. McCrary emphasizes the claim that the regression model measures only a comparison of spreads between the final six months of the Class Period and the first six months of the Clean Period. I have explained above why this critique is incorrect. It is also worth

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Period. This means that (holding other factors constant), Dr. Kleidon is attempting to measure the effect of the alleged conspiracy by searching for a decrease in observed spreads during just one day of the clean period.

69. Kleidon Declaration ¶¶17-21.

70. Kleidon Declaration Figure 2, showing a decline in *R*-squared relative to my original model.

71. Kleidon Declaration ¶5.

reemphasizing that Prof. McCrary's attempt to put a different label on the *exact same* effect is without basis in econometrics and, even ignoring this flaw, his results remain entirely consistent with inflated spreads during the Class Period. Table 1 above demonstrates that the relevant inflation coefficient, 0.0000408, is consistent throughout the entire Class Period. It can either be its own variable, or partially re-labeled as the same inflation distributed across all years of the Class Period. In either case, the inflation is present throughout the entirety of the Class Period.

38. Prof. McCrary also presents two other misleading modifications of my econometric model, as shown in columns (2) and (3) of his Exhibit 6. In these models, Prof. McCrary arbitrarily excludes statistically significant coefficients: in model (2), the 2013 statistically significant time fixed effect is excluded; in model (3), the statistically significant conduct coefficient is excluded. In doing so, he instructs the statistical software to assume that the effect of each of those variables is, respectively, equal to zero. Prof. McCrary has no basis in econometrics for discarding either the time fixed effect or the conduct coefficient. He, like Dr. Kleidon, does not cite to any authority to justify dropping highly significant variables that contribute substantially to the model's explanatory power (nor could he).<sup>72</sup> And omitting a statistically significant explanatory variable leads to omitted variable bias, contaminating the coefficients of his remaining explanatory variables.

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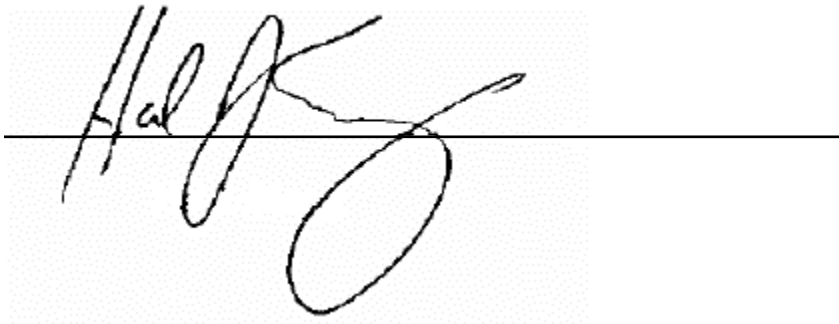
72. Singer Class Reply (January 31, 2019) ¶57.

### CONCLUSION

39. For the foregoing reasons, after carefully reviewing the arguments and analyses presented in the *Daubert* Memo and in the declarations of Dr. Kleidon and Prof. McCrary, I am not persuaded to revise any of my opinions.

\* \* \*

Hal J. Singer, PhD:

A handwritten signature in black ink, appearing to read "Hal J. Singer", is written over a horizontal line. The signature is stylized with large, sweeping loops. The background of the signature area is a light gray grid.

Executed on September 14, 2022.

## **APPENDIX: MATERIALS RELIED UPON**

### **CASE MATERIALS**

Class Certification Report of Hal J. Singer, Ph.D. (May 31, 2018)

Class Certification Rebuttal Report of Hal J. Singer, Ph.D. (January 31, 2019)

Declaration of Allan W. Kleidon, Ph.D. (August 26, 2022)

Declaration of Prof. Justin McCrary (August 26, 2022)

Expert Report of Divya Mathur, Ph.D. (May 20, 2022)

Memorandum of Law in Support of Credit Suisse Defendants' *Daubert* Motion to Exclude Plaintiffs' Proposed Expert Opinions (August 26, 2022)

Merits Report of Hal J. Singer, Ph.D. (January 23, 2020)

Merits Rebuttal Report of Hal J. Singer, Ph.D. (August 13, 2020)

Opinion and Order, ECF 1880

Rebuttal Report of Hal J. Singer, Ph.D. (July 31, 2022)

### **LITERATURE**

Joyaditya Laik & Prakash Mirchandani, *Effect of seasonality, sales growth rate, and fiscal year end on cash conversion cycle*, DECISION SCIENCES 1–21 (2021), available at <https://drive.google.com/file/d/1YyHA7UkRzyIUV97Xx5tb0d7V4cd01CEP/view>

Carol Osler & Xuhang Wang, *The Microstructure of Currency Markets*, in H. KENT BAKER AND HALIL KIYMA MARKET MICROSTRUCTURE IN EMERGING AND DEVELOPED MARKETS: PRICE DISCOVERY, INFORMATION FLOWS, AND TRANSACTION COSTS 79-97 (Chapter 5) (John Wiley 2013)

Carol Osler, *Market Microstructure, Foreign Exchange*, in ENCYCLOPEDIA OF COMPLEXITY AND SYSTEM SCIENCE 607-608 (Springer 2011)

Paul Oyer *Fiscal year ends and nonlinear incentive contracts: the effect on business seasonality*, 113(1) QUARTERLY JOURNAL OF ECONOMICS 149–185 (1998)

Richard Payne, *Informed trade in spot foreign exchange markets: An empirical investigation*, 61 JOURNAL OF INTERNATIONAL ECONOMICS (2003) 307–329

ADAM SMITH, AN INQUIRY INTO THE NATURE AND CAUSES OF THE WEALTH OF NATIONS (W. Strahan & T. Cadell, London 1776).

MICHAEL D. WHINSTON, LECTURES ON ANTITRUST ECONOMICS (MIT Press 2008)

JEFFREY WOOLDRIDGE, INTRODUCTORY ECONOMETRICS: A MODERN APPROACH (South-Western Cengage Learning 4th ed. 2009)

**BATES DOCUMENTS**

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